Space Weather Technical Forecast

Issued on Sunday, 02 October 2022 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor or G2/Moderate storms day 1 (2nd), then likely day 3 (4th). M-class flares likely throughout. Slight chance of S1/Minor radiation storm during day 1 (2nd). Chance of Active electron fluence later in the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, with an M5.8 flare observed at 01/2010 UTC, and an M8.3 flare observed at 02/0220 UTC, both from AR3110 in the northwest. This region has developed a north-south aligned magnetic structure, which may contribute to some magnetic instability. AR3112, which continues to rotate into view on the northeast limb, is the largest region. It is currently difficult to classify due to foreshortening near the limb, but it has been the source of several CMEs over recent days. There are currently six numbered sunspots on the Earth-facing disc. The remaining regions appear largely stable with little change.

Three CMEs have been observed from AR3113, and AR3110, these may pile-up and combine to give a glance at Earth around 04/0300 UTC.

Solar Wind / Geomagnetic Activity: Solar wind parameters at L1, as measured by DISCOVR and ACE, have been indicative of an ongoing weak HSS, with a weak CME arrival at 01/1500 UTC. Wind speeds have been mostly slightly elevated, in the range 380-530km/s. Density was below average. The total IMF, Bt, started weak, jumping to moderate when the CME was thought to arrive around 01/1500 UTC, before falling back to weak by 02/0500 UTC. The north-south component, Bz, varied weakly between +7/-5 nT. The phi angle was positive (away from the Sun). The resultant geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, is currently just above normal background levels, below the S1/Minor Storm threshold. High energy electron flux (greater than 2 MeV) was at background levels. The associated 24-hour fluence remained well below the Active (1e8 integrated pfu) threshold. Observed fluence at 02/0000UTC was 1.46e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Moderate, with further M-flares likely from AR3112, AR3110 and AR3113.

Solar Wind / Geomagnetic Activity: Three CMEs have erupted from the northwest quadrant in the past 24 hours. All three CME's are expected to combine, giving a glancing impact at earth, with an expected arrival time around 04/0300 at Earth.

Solar winds are currently slightly elevated. CH28/+ is now very late, with a chance of rising to 500-550 km/s should it arrive during day 1 (2nd). Solar winds should then ease during day 2 (3rd) back to slightly elevated or background levels before the combined CME's bring a possible solar wind speed of around 550/600 km/s during day 3 (4th). Solar winds should then fall back to background levels through day 4 (5th).

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Geomagnetic activity will be Quiet to Unsettled (Kp 0-3) initially, with a chance of becoming Active G1/Minor storm (Kp 4-5), and a slight chance of a G2/Moderate storm interval (Kp 6) with any late arrival of CH28/+. Geomagnetic activity should ease into day 2 (3rd), before the arrival of the three CME's either late day 2 (3rd) or more likely early day 3 (4th), with G1/G2 Minor/Moderate storming (Kp 5-6) considered likely. Geomagnetic activity should ease once again into day 4 (5th) back to Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is currently above background after the M5.8 flare from the northwest. There is a slight chance proton levels will breach the S1/Minor Storm threshold during Day 1 (02 Oct), with a gradual decrease likely thereafter in the absence of further large flares from the western hemisphere. The high energy (greater than 2MeV) electron flux has been at background levels. A rise in electron flux may occur after the HSS from CH28, but this will be complicated by the potential for three CME arrivals on days 2 or 3 (03-04 Oct) which would suppress electron levels. If the CME arrival(s) do not occur, a rise is possible during this period but confidence is low. The associated electron 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but perhaps with a rising trend.

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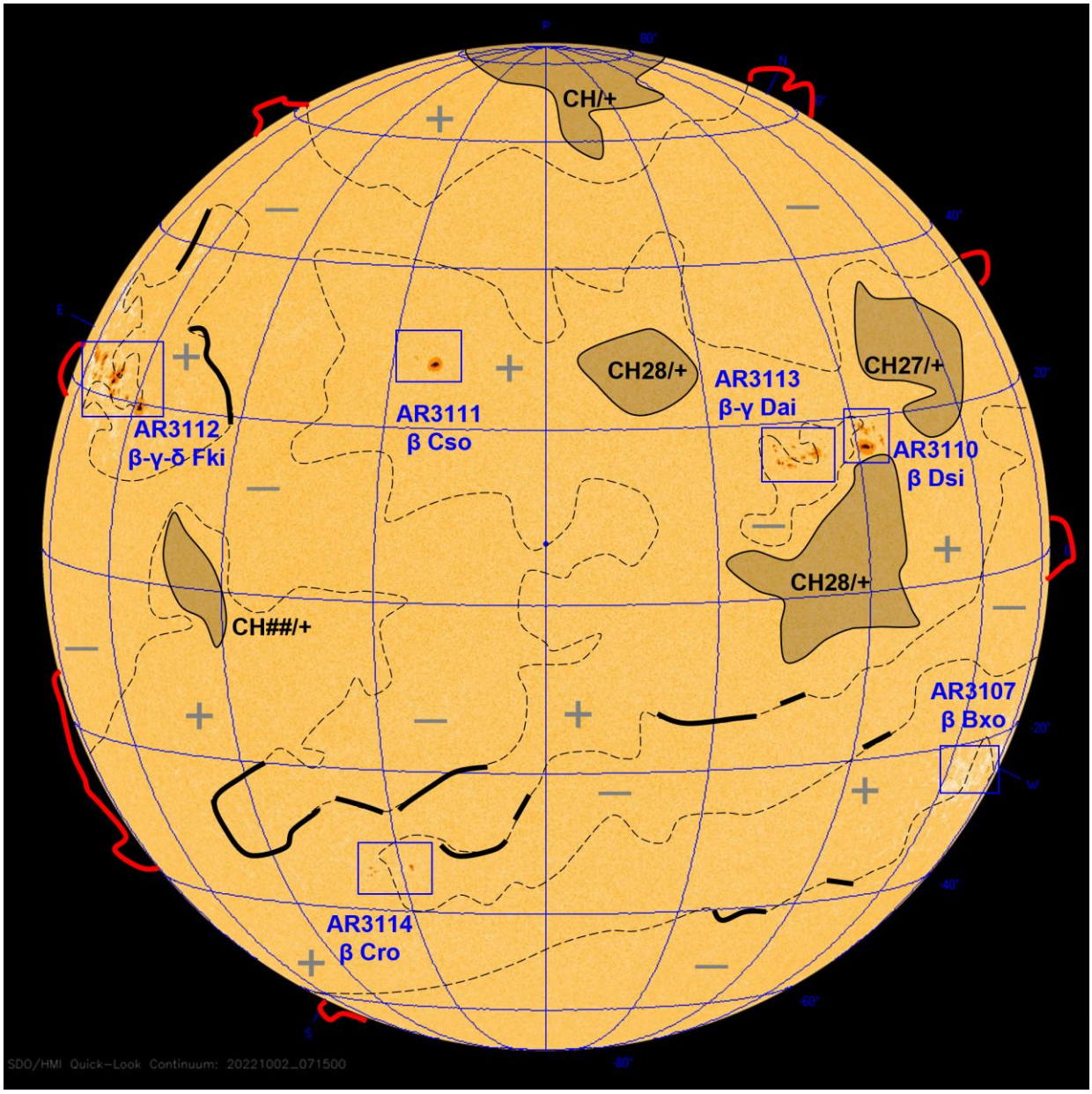
Figure 1. Solar Analysis Valid 02/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

Three CMEs have erupted from the northwest quadrant in the past 24 hours - one from AR3113 starting around 01/1200 UTC, and two from AR3110 associated the M5.8 and M8.3 flares at 01/2010 and 02/0220 UTC respectively. All three CME's are expected to combine, giving a glancing impact at earth, with an expected arrival time around 04/0300 +/-9 hours at Earth.

Solar winds are currently slightly elevated. There remains a chance that the fast wind of recurrent CH28/+ has not yet arrived, though this is considered late now and therefore reduced the risk of significant geomagnetic activity should it arrive. This coronal hole brought an extended period of Minor to Moderate geomagnetic storming on the last rotation. There is a chance of solar winds to rising during day 1 (2nd), with a peak of 500-550km/s. Solar winds should then ease during day 2 (3rd) back to slightly elevated or background levels before the combined CME's bring a possible solar wind speed of around 550/600 km/s during day 3 (4th). Solar winds should then fall back to background levels through day 4 (5th).

Geomagnetic activity will be Quiet to Unsettled (Kp 0-3) initially, with a chance of becoming Active G1/Minor storm (Kp 4-5) with any late arrival of CH28/+. There remains a slight chance of a G2/Moderate storm interval (Kp 6) during day 1 (2nd). Geomagnetic activity should ease into day 2 (3rd), before the arrival of the three CME's either late day 2 (3rd) or more likely early day 3 (4th). Geomagnetic activity should ease once again into day 4 (5th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	20	60	10
Strong	G3	No	1	1	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1643	Partial	AR3113	NW	850 km/s	04/0300 UTC	Low confidence glancing blow
01/2257	Partial	AR3110	NW	1130 km/s	04/0300 UTC	Pile up with above CME likely ahead but may combine.
02/0559	Partial	AR3110	NW	900 km/s	04/0300 UTC	Pile up with above CME's likely ahead but may combine.

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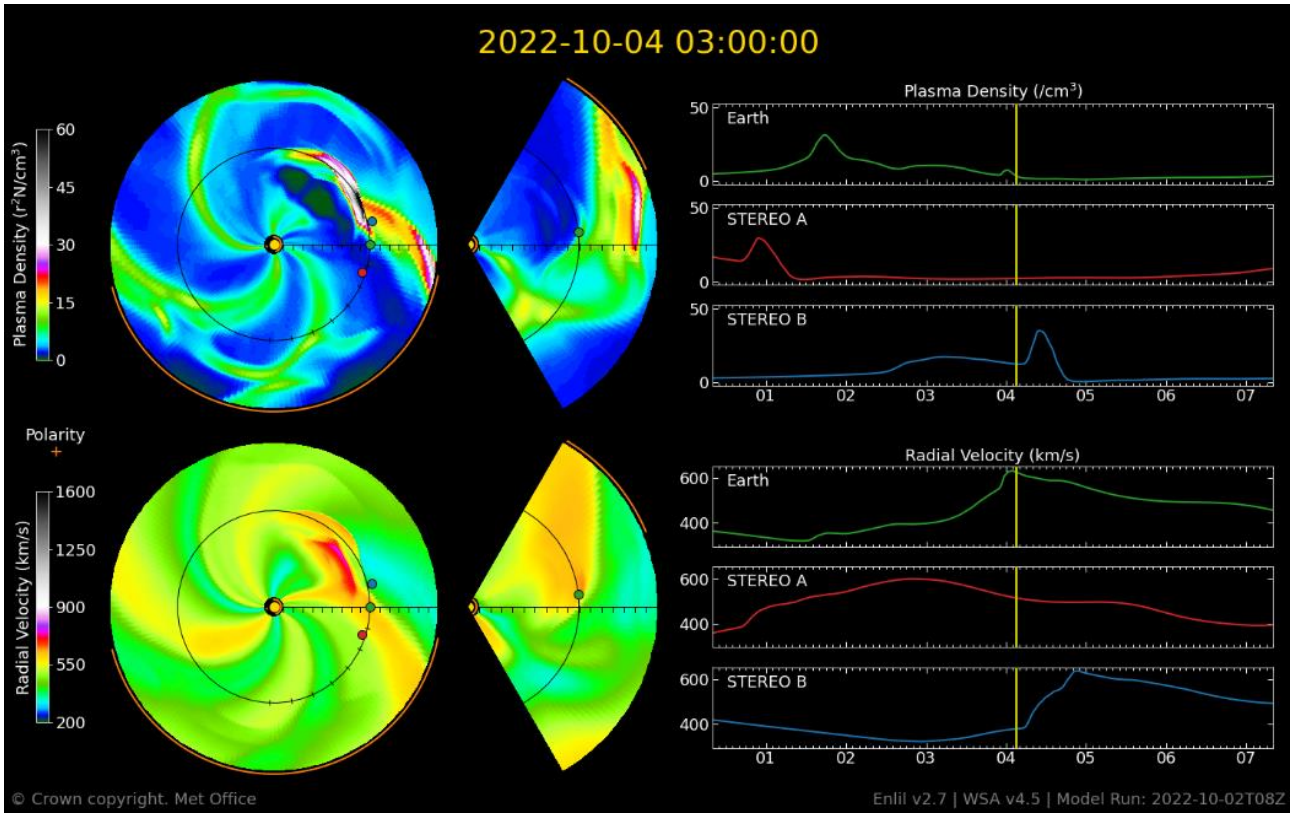
Figure 2: ENLIL showing possible CME arrivals around 04/0300UTC, low confidence in HSS arrival affecting CME arrivals.



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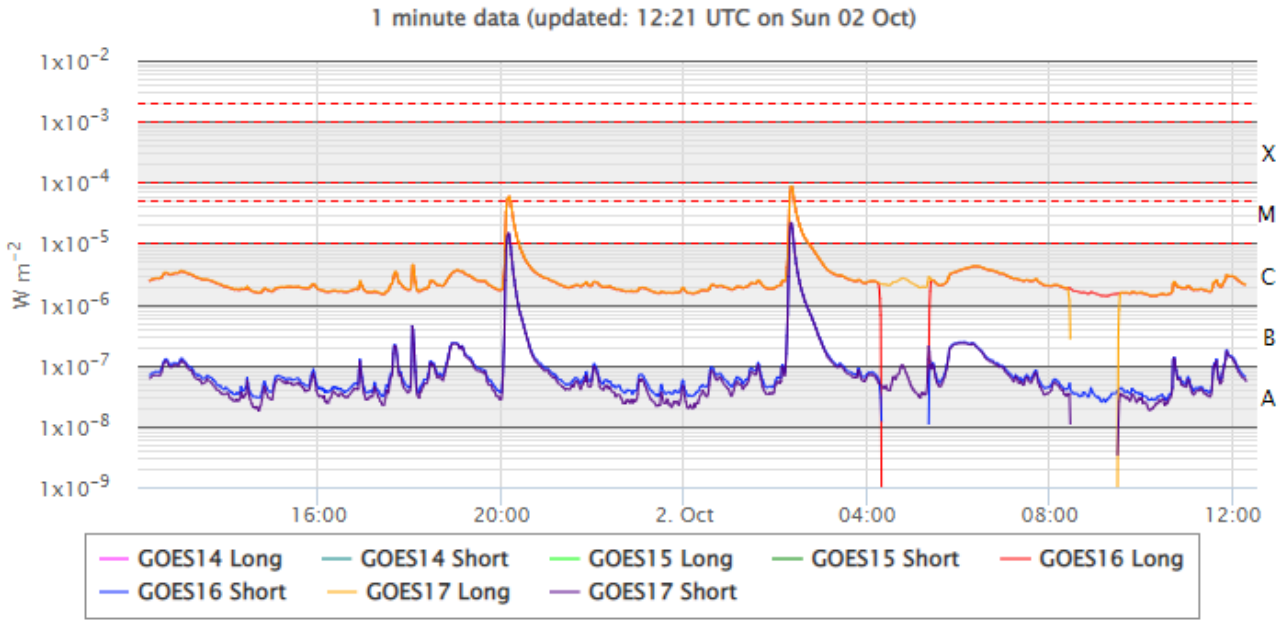
Radio Blackouts - X-Ray Flares:

There are currently six numbered sunspots on the Earth-facing disc. The largest region is AR3112 which has recently rotated onto the northeast limb, is slowly becoming more clearly visible. This has been classified as Fki/Beta-Gamma-Delta, but will be adjusted as necessary as the region rotates further onto the disc. It may be that there are two separate regions but foreshortening makes it difficult to tell at present, yet this region appears to be growing in areal extent. AR3110 has developed further in recent imagery, becoming larger with a N-S aligned magnetic structure giving some additional magnetic instability. AR3113 just to the east of AR3110, and previously considered the same spot, is also showing signs of recent growth. This spot has become a little more magnetically complex in recent hours and it's magnetic lines seem to be entangled with AR3110 once again, thus likely contributing to the recent increased action of late. The remaining regions are either stable, or have only shown minor changes.

Solar activity has been Moderate in the last 24 hours, with two M-class flares. An M5.8 at 01/2010 UTC and a M8.7 at 02/0221 UTC, both from AR3110. AR3112 also has a history of low level M-flares in recent days when it was on or just around the northeast limb. Further M-class flares are considered likely, either from AR3112, AR3110 and perhaps AR3113. The proton probability remains above average and above raw values due to the recent flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 3: 24 hour x-ray trace showing M flares from AR3110



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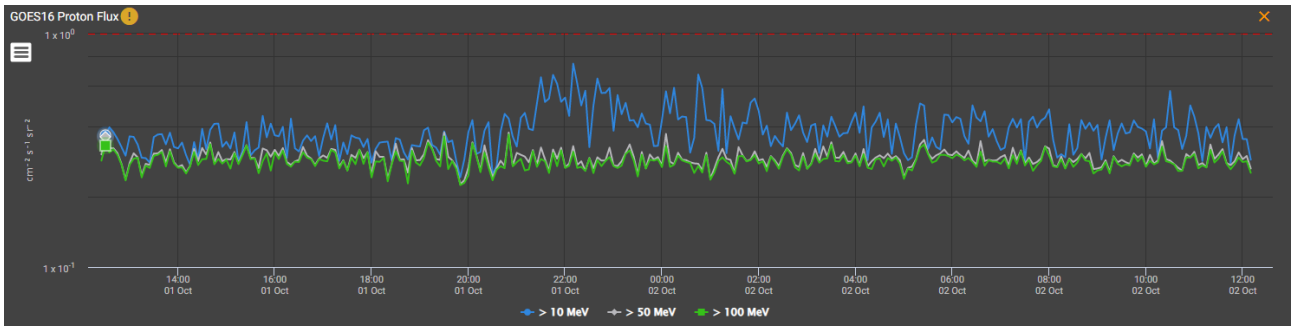
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16, is currently above background after the M5.8 flare from AR3110 at 01/2010 UTC in the northwest. A further rise is possible, with a slight chance that proton levels will reach the S1/Minor Storm threshold during Day 1 (02 Oct). After Day 1, a gradual decrease in levels is most likely, in the absence of further large flares from the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	15	15	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour Proton trace showing above background levels since M5.8 flare from AR3110.



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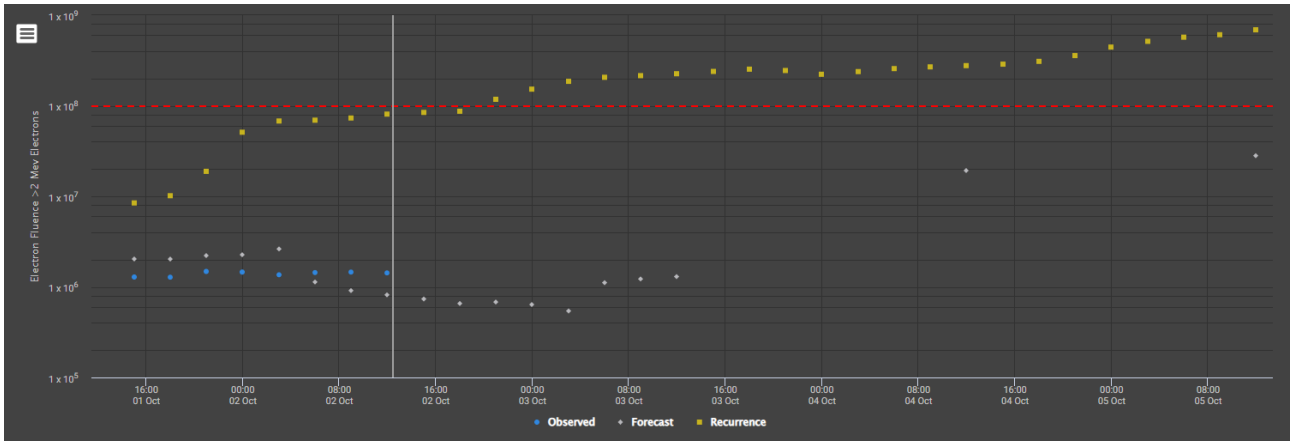
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux has been at background levels. A rise in electron flux may occur after the HSS from CH28, but this will be complicated by the potential for three CME arrivals on days 2 or 3 (03-04 Oct) which would suppress electron levels. If the CME arrival(s) do not occur, a rise is possible during this period but confidence is low.

The associated electron 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but perhaps with a rising trend. MOSWOC REFM is currently forecasting a slight rise below Active levels, but will not be taking account of any CME arrival. The persistence element of REFM was enhanced considerably due to the large amount of charging that occurred from CH28/+ on it's previous rotation, as this has not occurred this rotation, this is considered very unlikely.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: REFM integrated flux and fluence observations, persistence and forecast.



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